

WHAT IS CLAIMED IS:

1. A projection exposure apparatus which irradiates a pattern formed on a mask with a predetermined exposing energy beam and which projects an image of the pattern on the mask onto a substrate through a projection optical system, comprising:

an attenuation factor characteristic storage system which stores a fluctuation in an attenuation factor of the projection optical system in accordance with a total entered energy entering into the projection optical system; and

an attenuation factor acquisition system connected to the storage to calculate the total entered energy entering into the projection optical system through the mask and to acquire an attenuation factor of the projection optical system upon exposure on the basis of a value of the total entering energy and on the fluctuation in the attenuation factor thereof stored in the attenuation factor characteristic storage system.

2. The projection exposure apparatus as claimed in claim 1, wherein:

the fluctuation in the attenuation factor is a function of the value of the total entered energy entering into the projection optical system through the mask.

3. The projection exposure apparatus as claimed in claim 1, wherein:

the total entered energy entering into the projection optical system through the mask is calculated on the basis of a transmittance of the mask.

4. The projection exposure apparatus as claimed in claim 1, wherein:

the projection exposure apparatus projects the image of the pattern on the mask onto the substrate by relatively scanning the mask with the exposing energy beam.

5. The projection exposure apparatus as claimed in claim 4, wherein:

the total entered energy entering into the projection optical system through the mask is calculated by using information on a relative position of the exposing energy beam and the mask.

6. The projection exposure apparatus as claimed in claim 4, wherein:

the information on the relative position is an optical characteristic of the mask in accordance with the relative position of the exposing energy beam and the mask.

7. The projection exposure apparatus as claimed in claim 6, wherein:

the optical characteristic of the mask contains a characteristic of the transmittance of the mask.

8. The projection exposure apparatus as claimed in claim 1, further comprising:

an entering energy measurement system disposed on a path of the exposing energy beam to measure the total entered energy entering into the projection optical system through the mask.

9. The projection exposure apparatus as claimed in claim 8, further comprising:

a leaving energy measurement system disposed on the path of the exposing energy beam to measure a leaving energy leaving from the projection optical system.

10. The projection exposure apparatus as claimed in claim 9, wherein:

the fluctuation in the attenuation factor is given on the basis of results of measurement of the entering energy measurement system and the leaving energy measurement system.

11. The projection exposure apparatus as claimed in claim 8, wherein:

the entering energy measurement system measures the total entered energy entering into the projection optical system through the mask in a state in which the exposing energy beam and the mask are transferred relatively to each other.

12. The projection exposure apparatus as claimed in claim 8, wherein:

the projection exposure apparatus is to project the image of the pattern formed on the mask on the substrate by relatively scanning the mask with the exposing energy beam; and the total entered energy entering into the projection optical system through the mask is measured while relatively scanning the mask with the exposing energy beam in a manner like upon exposure.

13. The projection exposure apparatus as claimed in claim 1, further comprising:

an exposure control system connected to the storage system to control an exposure quantity to be provided on

the substrate on the basis of the fluctuation in the attenuation factor.

14. The projection exposure apparatus as claimed in claim 13, wherein:

the attenuation factor characteristic storage system stores an attenuation factor of the projection optical system for the total entering energy as well as a fluctuation in the attenuation factor of the projection optical system for an elapsed time after suspension of irradiation of the projection optical system with the exposing energy beam.

15. The projection exposure apparatus as claimed in claim 14, wherein:

the attenuation factor of the projection optical system is given on the basis of two kinds of fluctuations in the attenuation factor stored in the attenuation factor characteristic storage system, the total entered energy entering into the projection optical system, and the elapsed time.

16. The projection exposure apparatus as claimed in claim 15, wherein:

the exposure quantity to be provided on the substrate is controlled on the basis of the given attenuation factor.

17. The projection exposure apparatus as claimed in claim 4, further comprising:

a stage system which transfers each of the mask and the substrate;

wherein the mask and the substrate are scanned through

the stage system in synchronization with the projection optical system upon exposure.

18. The projection exposure apparatus as claimed in claim 1, wherein:

the exposing energy beam is an energy beam having a wavelength in an ultraviolet region.

19. A projection exposure apparatus which irradiates a pattern formed on a mask with a predetermined exposing energy beam and which projects an image of the pattern on the mask onto a substrate through a projection optical system, comprising:

an attenuation factor characteristic storage system which stores a fluctuation in an attenuation factor of the projection optical system in accordance with a total entered energy entering into the projection optical system through the mask.

20. The projection exposure apparatus as claimed in claim 19, wherein:

the fluctuation in the attenuation factor is a function of a value of the total entered energy entering into the projection optical system through the mask.

21. The projection exposure apparatus as claimed in claim 19, wherein:

the total entered energy entering into the projection optical system through the mask is calculated on the basis of a transmittance of the mask.

22. The projection exposure apparatus as claimed in claim 19, wherein:

the projection exposure apparatus projects the image of the pattern on the mask onto the substrate by relatively scanning the mask with the exposing energy beam.

23. The projection exposure apparatus as claimed in claim 22, wherein:

the total entered energy entering into the projection optical system through the mask is calculated by using information on a relative position of the exposing energy beam and the mask.

24. The projection exposure apparatus as claimed in claim 22, wherein:

the information on the relative position is an optical characteristic of the mask in accordance with the relative position of the exposing energy beam and the mask.

25. The projection exposure apparatus as claimed in claim 24, wherein:

the optical characteristic of the mask contains a characteristic of the transmittance of the mask.

26. The projection exposure apparatus as claimed in claim 19, further comprising:

an entering energy measurement system disposed on a path of the exposing energy to measure the total entered energy entering into the projection optical system through the mask.

27. The projection exposure apparatus as claimed in claim 26, wherein:

the entering energy measurement system measures the total entered energy entering into the projection optical

system through the mask in a state in which the exposing energy beam and the mask are transferred relatively to each other.

28. The projection exposure apparatus as claimed in claim 27, wherein:

the projection exposure apparatus is to project the image of the pattern formed on the mask onto the substrate by relatively scanning the mask with the exposing energy beam; and the total entered energy entering into the projection optical system through the mask is measured while relatively scanning the mask with the exposing energy beam in a manner like upon exposure.

29. The projection exposure apparatus as claimed in claim 19, wherein:

the exposing energy beam is an energy beam having a wavelength in an ultraviolet region.

30. A method for manufacturing a projection exposure apparatus which irradiates a pattern formed on a mask with a predetermined exposing energy beam and which projects an image of the pattern formed on the mask onto a substrate through a projection optical system, said method is characterized by the steps of:

installing an attenuation factor characteristic storage system which stores a fluctuation in an attenuation factor of the projection optical system in accordance with a total entered energy entering into the projection optical system; and

installing an attenuation factor acquisition system

connected to the storage to calculate a total entered energy entering into the projection optical system through the mask and which acquires an attenuation factor of the projection optical system upon exposure on the basis of a value of the total entering energy and on the fluctuation in the attenuation factor thereof stored in the attenuation factor characteristic storage system.

31. The method for manufacturing the projection exposure apparatus as claimed in claim 30, wherein:

a substrate is formed by using the projection exposure apparatus manufactured by the method.

32. The manufacturing method as claimed in claim 30, wherein:

the fluctuation in the attenuation factor is a function of the value of the total entered energy entering into the projection optical system through the mask.

33. The manufacturing method as claimed in claim 30, wherein:

the total entered energy entering into the projection optical system through the mask is calculated on the basis of a transmittance of the mask.

34. The manufacturing method as claimed in claim 30, wherein:

the total entered energy entering into the projection optical system through the mask is calculated by using information on a relative position of the exposing energy beam and the mask.

35. The manufacturing method as claimed in claim 34,



wherein:

the information on the relative position is an optical characteristic of the mask in accordance with the relative position of the exposing energy beam and the mask.

36. The manufacturing method as claimed in claim 35, wherein:

the optical characteristic of the mask contains a characteristic of the transmittance of the mask.

37. The manufacturing method as claimed in claim 30, further comprising:

installing an entering energy measurement system disposed on a path of the exposing energy beam to measure the total entered energy entering into the projection optical system through the mask.

38. The manufacturing method as claimed in claim 30, further comprising:

installing a leaving energy measurement system disposed on a path of the exposing energy to measure the leaving energy leaving from the projection optical system.

39. The manufacturing method as claimed in claim 30, further comprising:

installing an exposure control system connected to the storage system to control an exposure quantity to be provided on the substrate on the basis of the fluctuation in the attenuation factor.

40. The manufacturing method as claimed in claim 30, wherein:

the exposing energy beam is an energy beam having a

wavelength in an ultraviolet region.

41. An exposure method for irradiating a pattern formed on a mask with a predetermined exposing energy beam and projecting an image of the pattern formed on the mask onto a substrate through a projection optical system, comprising:

obtaining a fluctuation in an attenuation factor of the projection optical system in accordance with a total entered energy entering into the projection optical system; and

obtaining an attenuation factor of the projection optical system on the basis of a value of a total entered energy entering into the projection optical system through the mask and on the fluctuation in the attenuation factor thereof.

42. The exposure method as claimed in claim 41, wherein: the total entered energy entering into the projection optical system through the mask is calculated on the basis of a transmittance of the mask.

43. The exposure method as claimed in claim 41, wherein: the total entered energy entering into the projection optical system through the mask is calculated by using information on a relative position of the exposing energy beam and the mask.

44. The exposure method as claimed in claim 43, wherein: the information on the relative position is an optical characteristic of the mask in accordance with the relative position of the exposing energy beam and the mask.

45. The exposure method as claimed in claim 44, wherein:

the optical characteristic of the mask contains a characteristic of the transmittance of the mask.

46. The exposure method as claimed in claim 41, wherein:

the total entered energy entering into the projection optical system through the mask is measured in a state in which the exposing energy beam and the mask are transferred relatively to each other.

47. The exposure method as claimed in claim 41, further comprising:

controlling an exposure quantity to be provided on the mask on the basis of the fluctuation in the attenuation factor.

48. The exposure method as claimed in claim 41, wherein:

the fluctuation in the attenuation factor of the projection optical system is given by using two types of the fluctuation, one type is the fluctuation of the projection optical system for the total entering energy, the other type is the fluctuation of the projection optical system for an elapsed time after irradiation of the projection optical system with the exposing energy beam is suspended.

49. The exposure method as claimed in claim 41, wherein:

the exposing energy beam is an energy beam having a wavelength in an ultraviolet region.

50. A method for manufacturing a circuit device by projecting an image of a pattern formed on a mask onto a substrate through a projection optical system, said method is characterized by the steps of:

coating the substrate with a photosensitive material;

exposing the image of the pattern on the mask to the substrate by controlling an exposure quantity onto the substrate on the basis of the attenuation factor of the projection optical system upon exposure, the attenuation factor being given on the basis of a fluctuation in an attenuation factor of the projection optical system for the total entered energy entering into the projection optical system through the mask and on the total entering energy; and

developing the substrate.

51. The exposure method as claimed in claim 50, wherein:

the total entered energy entering into the projection optical system through the mask is given on the basis of an optical characteristic of the mask in accordance with a relative position of the mask and the exposing energy beam.

52. An exposure method for irradiating a pattern formed on a mask with a predetermined exposing energy beam and projecting an image of the pattern formed on the mask onto a substrate through a projection optical system, comprising:

obtaining a fluctuation in an attenuation factor of the projection optical system in accordance with a total entered energy entering into the projection optical system;

correcting the total entered energy entering into the projection optical system on the basis of a pattern information on the pattern of the mask; and

obtaining an attenuation factor of the projection optical system on the basis of a value of the corrected total entering energy and on the fluctuation in the

attenuation factor of the projection optical system.

53. The exposure method as claimed in claim 52, wherein:  
the pattern information contains a transmittance of  
the mask.

54. The exposure method as claimed in claim 52, wherein:  
the pattern information contains a rate of the  
presence of a pattern on the mask.

55. The exposure method as claimed in claim 52, wherein:  
the pattern information is an optical characteristic  
of the mask in accordance with a relative position between  
the exposing energy beam and the mask.

56. The exposure method as claimed in claim 55, wherein:  
the optical characteristic of the mask contains a  
characteristic of a transmittance of the mask.

57. The exposure method as claimed in claim 55, wherein:  
the optical characteristic of the mask contains a rate  
of the presence of a pattern on the mask.

58. The exposure method as claimed in claim 52, further  
comprising:

controlling an exposure quantity to be provided on the  
substrate on the basis of the fluctuation in the attenuation  
factor

59. The exposure method as claimed in claim 52, wherein:  
the exposing energy beam is an energy beam having a  
wavelength in an ultraviolet region.

60. A projection exposure apparatus which irradiates a  
pattern formed on a mask with a predetermined exposing  
energy beam and which projects an image of the pattern

formed on the mask onto a substrate through a projection optical system, comprising:

an attenuation factor characteristic storage system which stores a fluctuation in an attenuation factor of the projection optical system in an elapsed time after suspension of the irradiation of the projection optical system with the exposing energy beam.

61. The projection exposure apparatus as claimed in claim 60, wherein:

the fluctuation in the attenuation factor is approximated as a function of the elapsed time after suspension of the irradiation of the mask with the exposing energy beam.

62. The projection exposure apparatus as claimed in claim 60, wherein:

the attenuation factor characteristic storage system further stores the fluctuation in the attenuation factor of the projection optical system in accordance with the total entered energy entering into the projection optical system.

63. The exposure method as claimed in claim 60, wherein:

the exposing energy beam is an energy beam having a wavelength in an ultraviolet region.

64. A method for manufacturing a projection exposure apparatus which irradiates a pattern formed on a mask with a predetermined exposing energy beam and which projects an image of the pattern formed on the mask onto a substrate through a projection optical system, said method is characterized by the steps of:

installing an attenuation factor characteristic storage system which stores a fluctuation in an attenuation factor of the projection optical system in accordance with an elapsed time after interruption of the irradiation of the projection optical system with the exposing energy beam; and

installing an attenuation factor acquisition system connected to the storage to acquire an attenuation factor of the projection optical system upon exposure on the basis of the fluctuation in the attenuation factor thereof stored in the attenuation factor characteristic storage system and the elapsed time.

65. The method for manufacturing the projection exposure apparatus as claimed in claim 64, wherein:

a substrate is formed by using the projection exposure apparatus manufactured by the method.

66. The manufacturing method as claimed in claim 64, further comprising:

installing an exposure control system connected to the storage system to control an exposure quantity to be provided on the substrate on the basis of the fluctuation in the attenuation factor.

67. The manufacturing method as claimed in claim 64, wherein:

the exposing energy beam is an energy beam having a wavelength in an ultraviolet region.

68. An exposure method for irradiating a pattern formed on a mask with a predetermined exposing energy beam and projecting an image of the pattern on the mask onto a

substrate through a projection optical system, comprising:

obtaining a fluctuation in an attenuation factor of the projection optical system in an elapsed time after interruption of the irradiation of the projection optical system with the exposing energy beam; and

controlling an exposure quantity on the substrate on the basis of the fluctuation in the attenuation factor.

69. The exposure method as claimed in claim 68, further comprising:

obtaining the fluctuation in the attenuation factor of the projection optical system for the total entered energy entering into the projection optical system after re-starting the irradiation of the projection optical system with the exposing energy beam; and

controlling the exposure quantity on the basis of the fluctuation in the attenuation factor during the interruption and the fluctuation in the attenuation factor after resumption of the interruption.

70. The exposure method as claimed in claim 68, wherein:

the fluctuation in the attenuation factor after the interruption is approximated as a function of the elapsed time after suspension of the irradiation of the mask with the exposing energy beam.

71. The exposure method as claimed in claim 68, wherein:

the exposing energy beam is an energy beam having a wavelength in an ultraviolet region.

72. A method for manufacturing a circuit device by projecting an image of a pattern formed on a mask onto a



substrate through a projection optical system, said method is characterized by the steps of:

coating the substrate with a photosensitive material;

exposing the image of the pattern on the mask to the substrate by controlling an exposure quantity on the substrate on the basis of the attenuation factor of the projection optical system, the attenuation factor upon exposure being given on the basis of a fluctuation in an attenuation factor of the projection optical system in a predetermined elapsed time after interruption of exposure of the mask; and

developing the substrate.

73. The exposure method as claimed in claim 72, wherein:

the total entered energy entering into the projection optical system through the mask is given on the basis of an optical characteristic of the mask in accordance with a relative position of the mask and the exposing energy beam.